**OC-0244**

**Prediction of cumulative bladder DVH in prostate cancer IGRT with a partial least squares (PLS) model**

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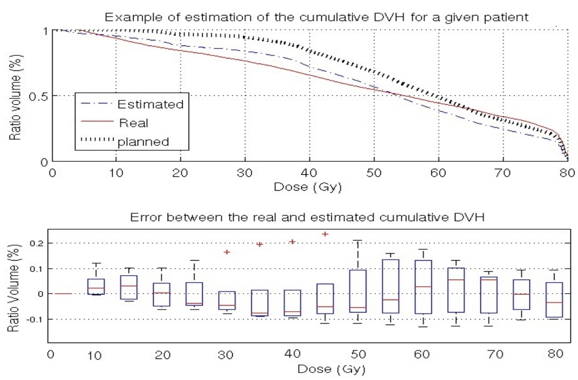
**Purpose/Objective:** In prostate cancer RT the delivered dose to organs at risk (bladder and rectum) may considerably differ from the planned dose distribution, likely impacting the risk of toxicity. Computing cumulative DVH during the treatment in IGRT, is crucial because it could help to prevent significant changes and would enable to generate alarms before a fraction, leading to a new planning re-computation when required. The aim of this study was to develop a model to predict the cumulative bladder DVH from the planned DVH using the initial volume of the bladder using multivariate statistics tools.

**Materials and Methods:** 20 patients, treated for prostate cancer with external radiotherapy had one planning CT and weekly CTs. The bladder was manually delineated by one expert on all CT scans. The actual cumulated dose during treatment was computed using non rigid registration from weekly CTs to the planning CT. Hence, cumulated bladder DVHs were computed using the propagated weekly doses to the baseline anatomy. From the weekly observed anatomical modifications, a set of features were extracted. Principal Component Analysis (PCA) was used to reduce the DVHs dimension and find relationships between planned and cumulative DVHs across the population. Then, Partial Least Squares (PLS) methodology was used to explain changes in DVHs with respect to the features obtained in the previous step. PLS is a methodology which enable to optimally relate changes between input and output data. Regressive PLS was finally used for training the population model, thereby, optimizing the features to predict cumulative DVHs. Thus, 15 patients randomly selected were used to train the model, and the 5 remaining patients for validation. In the validation, only the initial volume and the initial DVH were used as inputs. The cumulated DVHs were estimated with the model and compared with the actual computed cumulated DVHs.

**Results:** Results suggest that volume, deformation and superficial area are the main features related with DVH changes. In the validation, the mean error between estimated and cumulated DVH was 0.028 for all the bins. Figure 1 shows an exemple of planned, predicted and real cumulative DVHs for a given patient as well as the average error per dose bin.




**Conclusions:** Multivariate statistical techniques such as PCA and PLS seems to be a useful tool to analyze and to explain changes in DVH using anatomic features observed in IGRT. Using this information, we obtained a predictive model that provides a good approximation of the real cumulated DVHs. The interest relies in that after the training, the model uses only a single parameter (initial bladder volume). Future work include the estimation of the impact of the generated DVHs on toxicity. This work opens the road for adaptive correction by the generation of in online alarms when cumulated DVHs go to a region of high toxicity risk.

**OC-0245**

**MRI-based treatment plan simulation and adaptation for ion radiotherapy**

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**Purpose/Objective**

Accurate treatment planning and simulation are required to benefit from the highly conformal irradiation of tumors in ion radiotherapy. In the last years, the application of MRI for treatment planning has become more and more important. Thus, the purpose of this study was to investigate the potential of MRI for ion radiotherapy treatment plan simulation and adaptation in the head region.

**Materials and Methods:** We applied a classification-based (Bergé et al. 2012) tissue segmentation to derive so-called pseudo CT numbers (Johansson et al. 2011) from MR images of three patients with cerebral arteriovenous malformations scheduled for ion radiotherapy. Several MR imaging sequences (including a 3D ultrashort echotime sequence for distinguishing bone tissue from air) were evaluated in cross-validation studies. Then, ion radiotherapy treatment plans were optimized and simulated using both MRI-based pseudo CT and reference CT. Finally, a target shift of 1.6 mm in two directions was simulated and a treatment plan adapted to the shift was optimized on a corrected CT. The latter consists of a reference CT in which a volume around the target was replaced by pseudo CT values.

**Results:** The derivation of pseudo CT led to mean absolute errors in the range of 141 – 165 HU. Soft tissue was in good agreement with reference CT values. Most significant deviations appeared at transitions between different tissue classes and at air cavities and bones. The former originated from partial volume effects whereas the latter resulted from the low SNR of bones in MR imaging, even if the UTE sequence was applied. Simulations of ion radiotherapy treatment plans using pseudo CT revealed only small underdosages of a target volume compared to reference CT simulations. A plan adapted to the target volume shift and optimized on the corrected CT exhibited an improved target dose coverage compared to a non-adapted plan optimized on a reference CT. This result showed that the error introduced by replacing a volume of the reference CT containing solely soft tissue by pseudo CT values was significantly smaller than the error resulting from a target shift of 1.6 mm in two directions. In this case, MRI examinations before each fraction would give the opportunity of treatment plan adaptation to interfractional changes of anatomy or tumor movements without additional dose.

**Conclusions:** We demonstrated that an MRI-based derivation of pseudo CT values and treatment plan simulation in the head region are feasible. In the future, MRI may complement the treatment planning process for ion radiotherapy and improve the accuracy so as to reap the rewards of highly conformal irradiation of tumors with charged particles. Since ions represent a radiation modality being very sensitive to inaccuracies in treatment planning, this study is a reliable test if MRI-based treatment plan simulation is generally feasible.

## PROFFERED PAPERS: PHYSICS 6: DETECTOR DEVELOPEMENTS AND CHARACTERISATION

**OC-0246**

**Dosimetric characterization of a new commercial plastic scintillation detector in FFF MV photon beams**

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**Purpose/Objective:** An ideal detector for narrow field dosimetry would have good dose and dose rate linearity, energy independence, high spatial resolution, tissue equivalence, and orientation independence. This study evaluates the characteristics of a new commercial plastic scintillation detector in 6 MV and 10 MV high dose rate flattening-filter-free (FFF) photon beams from a linear accelerator for stereotactic field dosimetry.

**Materials and Methods:** A W1 Exradin plastic scintillation detector and a Supermax Electrometer from Standard Imaging (Middleton, WI USA) were used in FFF beams from a Varian TrueBeam STX machine. The scintillation detector has a 1mm by 3mm cylindrical sensitive volume coupled to an optical fiber. Dose calibration for the scintillator was performed in a special calibration phantom provided by the vendor. Resulting calibration factors were stored in the electrometer and were used to remove the optic fiber induced Cherenkov contamination from the signal using a chromatic subtraction algorithm. All in-phantom measurements were carried out in a 3D water tank and in-air measurements were performed using a custom built brass cap to maintain the electronic equilibrium in the